AERMIC Update

Roger W. Brode
U.S. EPA/OAQPS
Air Quality Modeling Group

2014 R/S/L Modelers' Workshop
May 21, 2014
Dallas, TX

“Recent” AERMIC Contributions

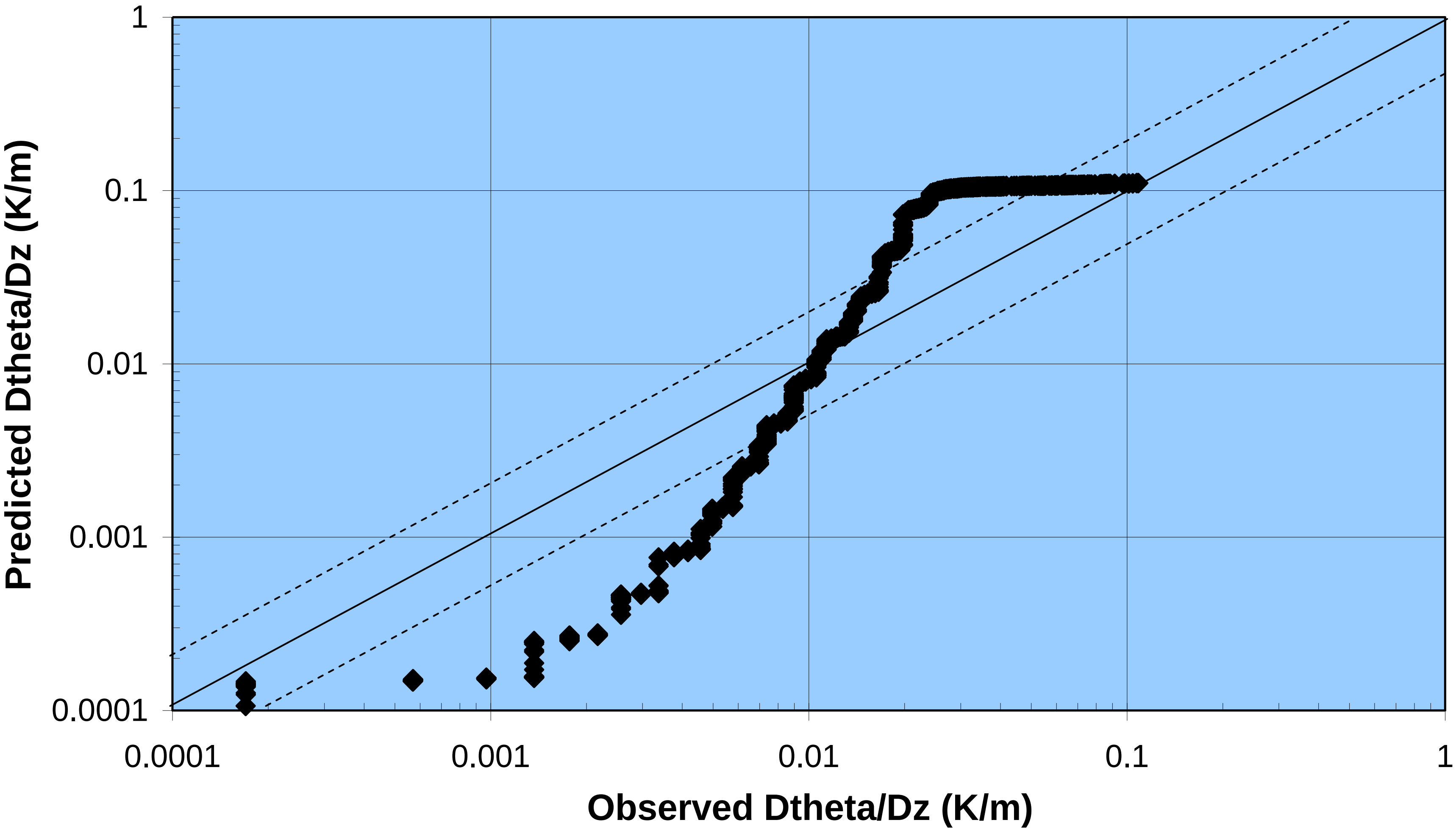
- Since AERMOD’s promulgation, AERMIC has addressed several specific issues that have arisen:
  - Assessed issues and developed appropriate approaches to address concerns about AERMOD model performance under low wind/stable conditions, contributing directly to new “low-wind” Beta options;
  - Addressed “line” source modeling capabilities, especially inconsistency in AERMOD where POINT and VOLUME sources incorporate horizontal meander algorithm, but AREA sources do not;
  - Developed method for estimating effective surface roughness, a key input to AERMET meteorological processor, incorporated in pending Beta version of AERSURFACE;
  - Reviewed building downwash issues and developed recommendations for alternative building parameters for PRIME algorithm in AERMOD, contributing to preliminary efforts to develop alternative building parameters, and leading to new EPA wind tunnel studies of these issues;
  - Provided recommendations related to the urban morning transition “formulation bug” fix incorporated in version 11059 of AERMOD.

Looking Ahead for AERMIC

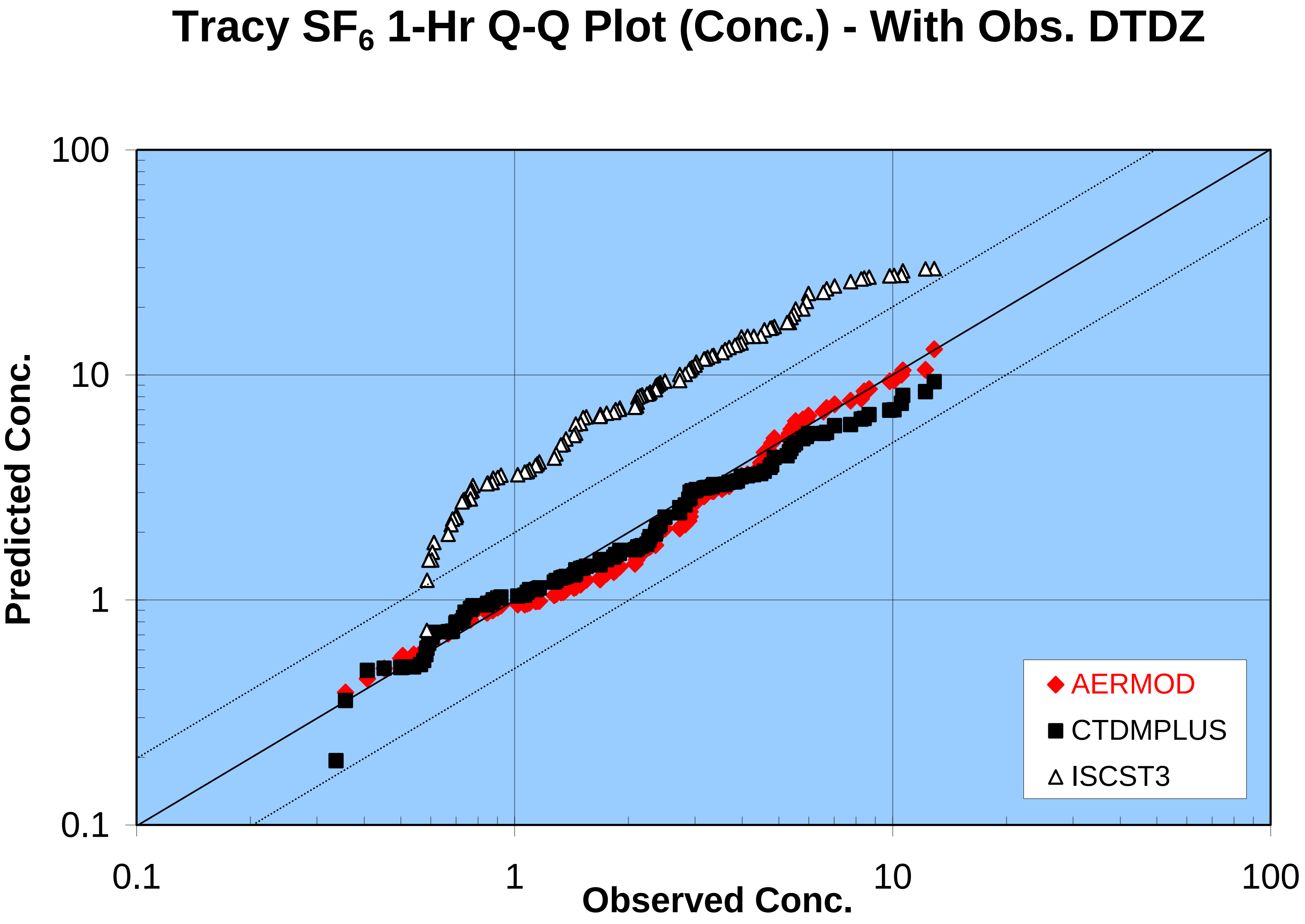
- Several potential issues were identified prior to promulgation of AERMOD, but were late enough in the process that promulgation would have been further delayed, including:
  - Default lapse rate used in AERMOD;
  - Interaction of elevated plumes with urban mixing height at night;
  - Determination of distance-dependent “effective” parameters (WS, turbulence), especially for low-level sources and penetrated plumes.
- Plan to incorporate modifications that are shown to improve model performance, initially as Beta options in AERMOD, with further consideration as possible regulatory default options at 11th Modeling Conference.
- Details regarding the default lapse rate issue are shown next:

Default Lapse Rate Issue

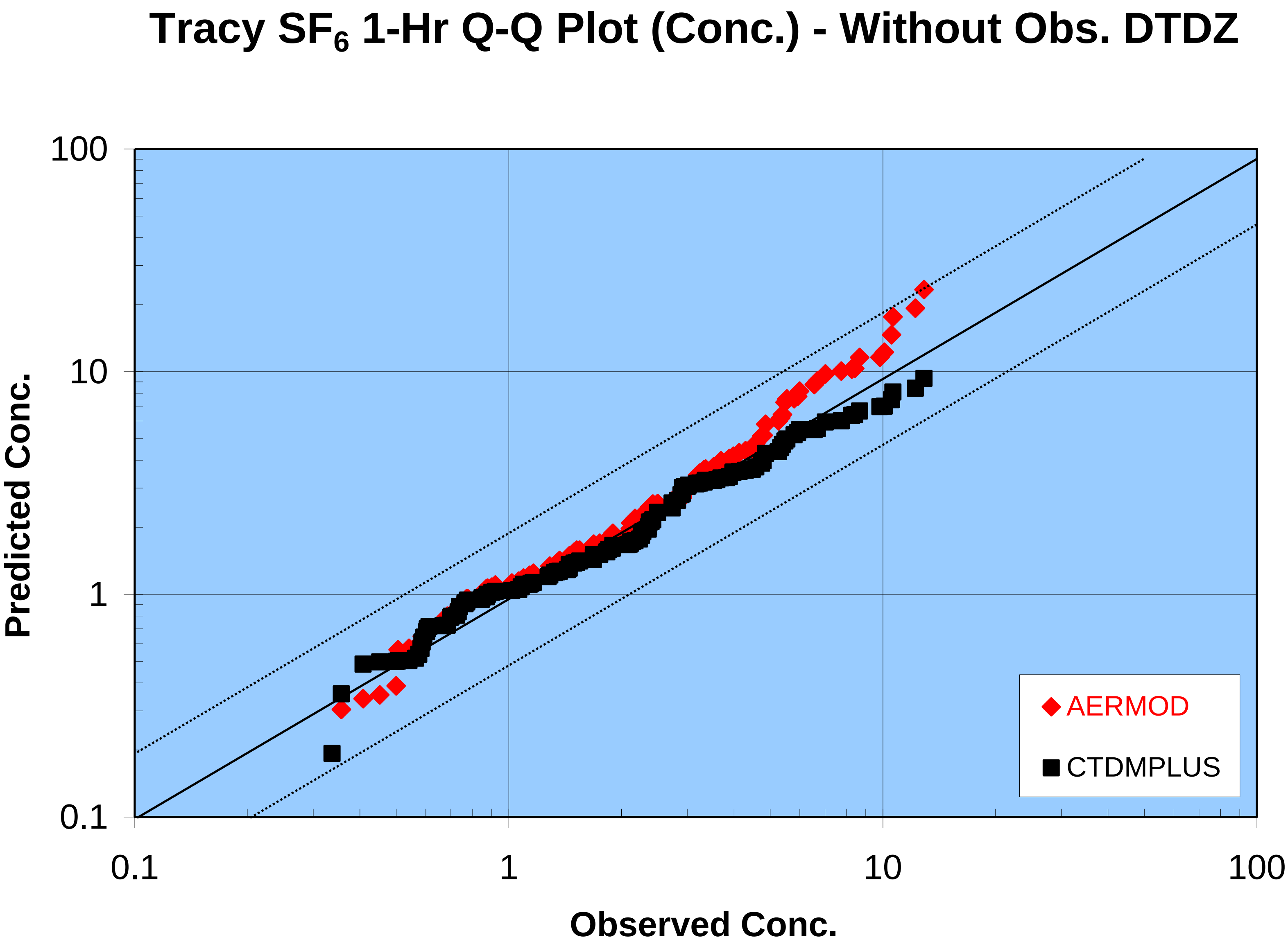
Q-Q Plot of Observed vs. Predicted Dtheta/Dz at Tracy



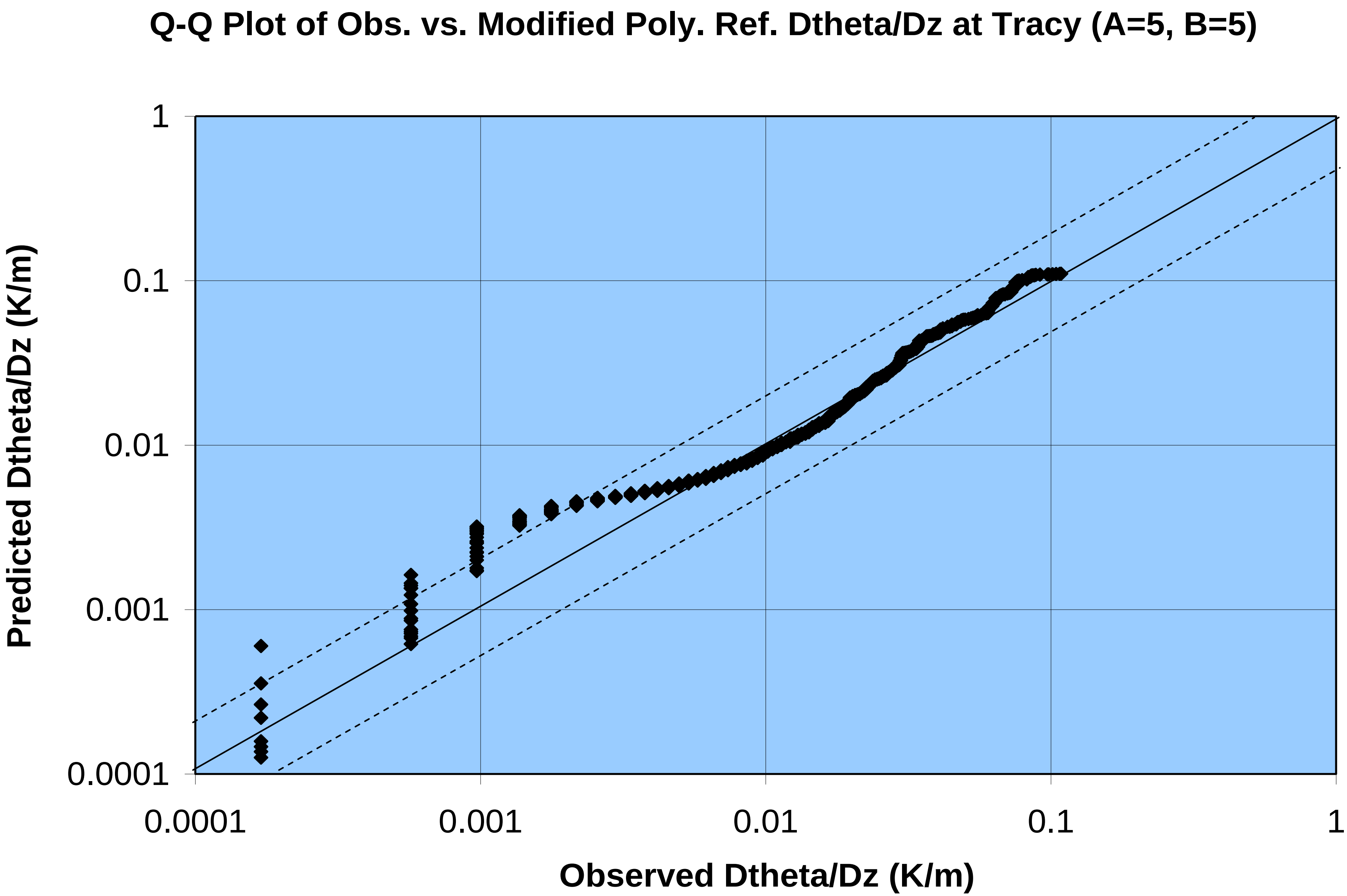
AERMOD Performance with Observed Lapse Rate



AERMOD Performance w/o Observed Lapse Rate

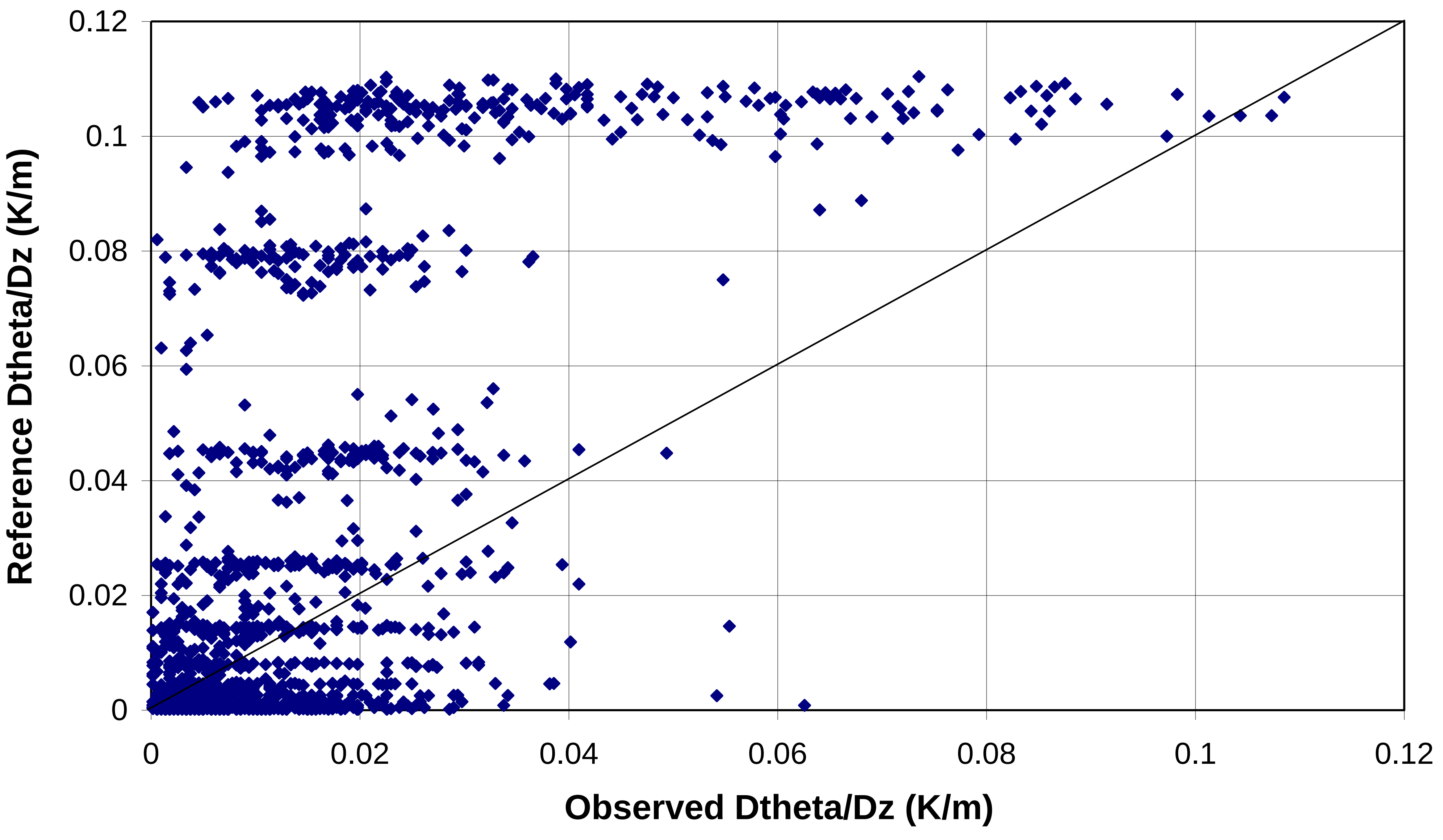


Potential Modified Lapse Rate



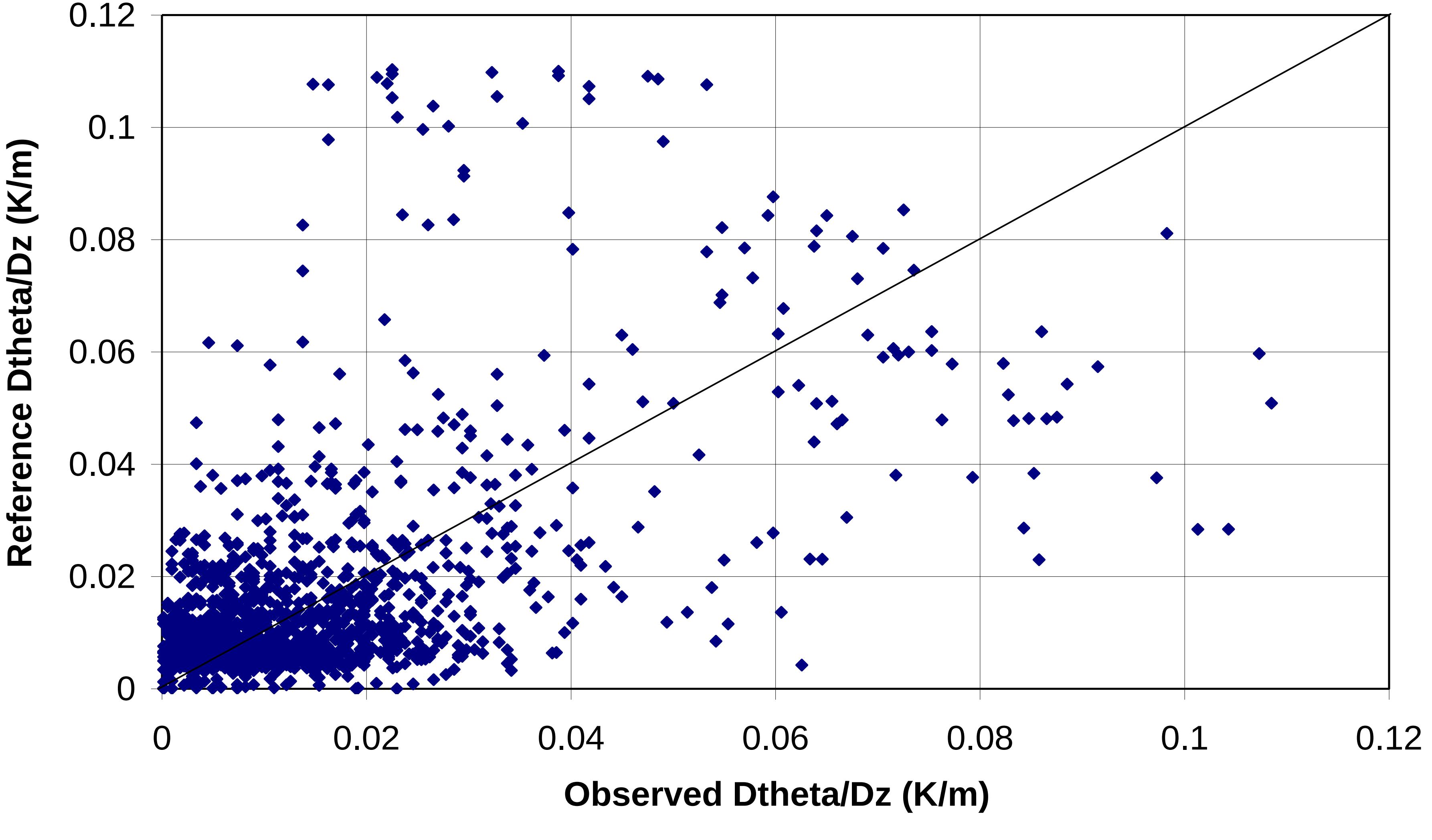
Default Lapse Rate Issue - Paired

Observed vs. Reference Dtheta/Dz at Tracy

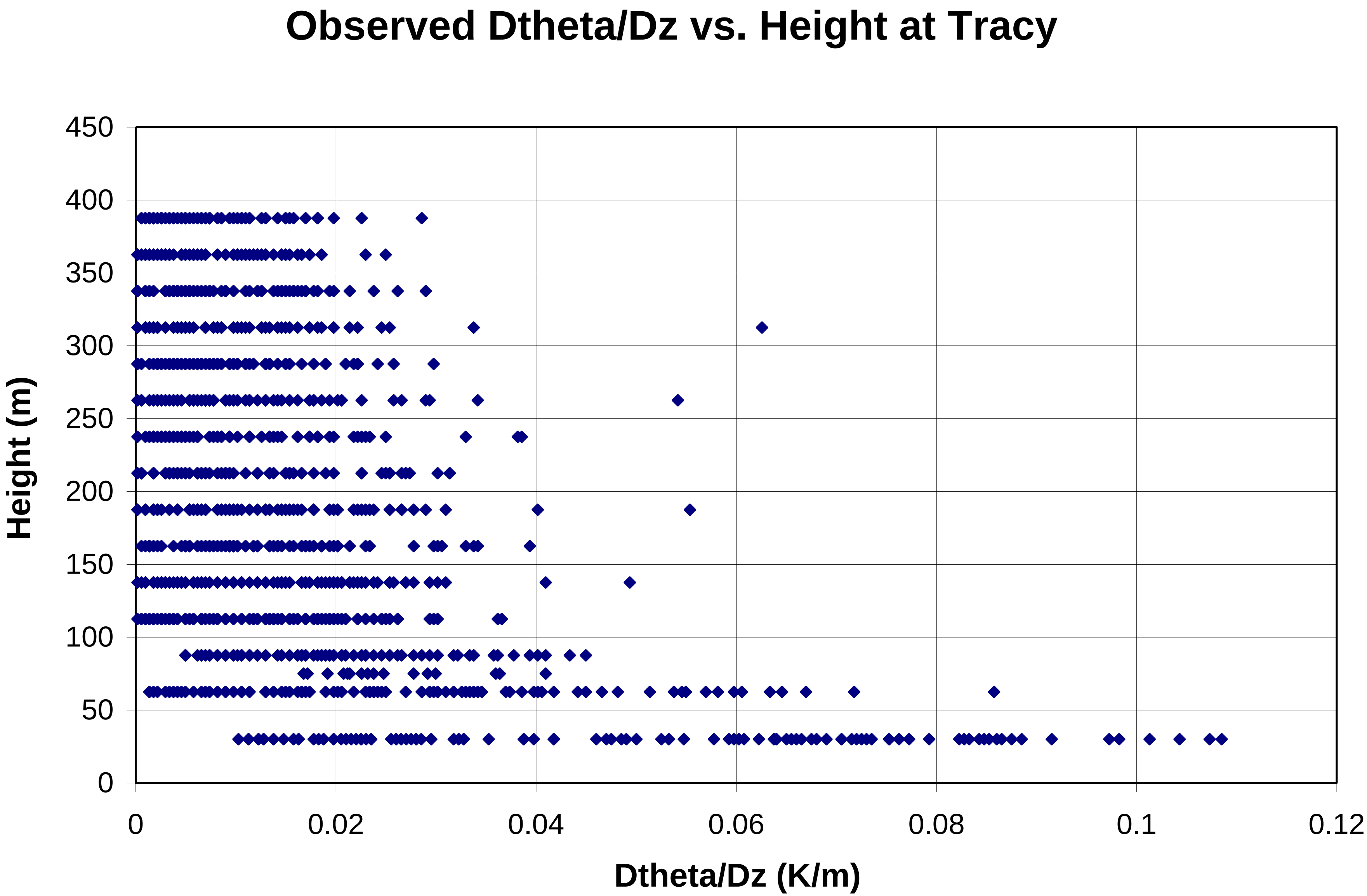


Potential Modified Lapse Rate - Paired

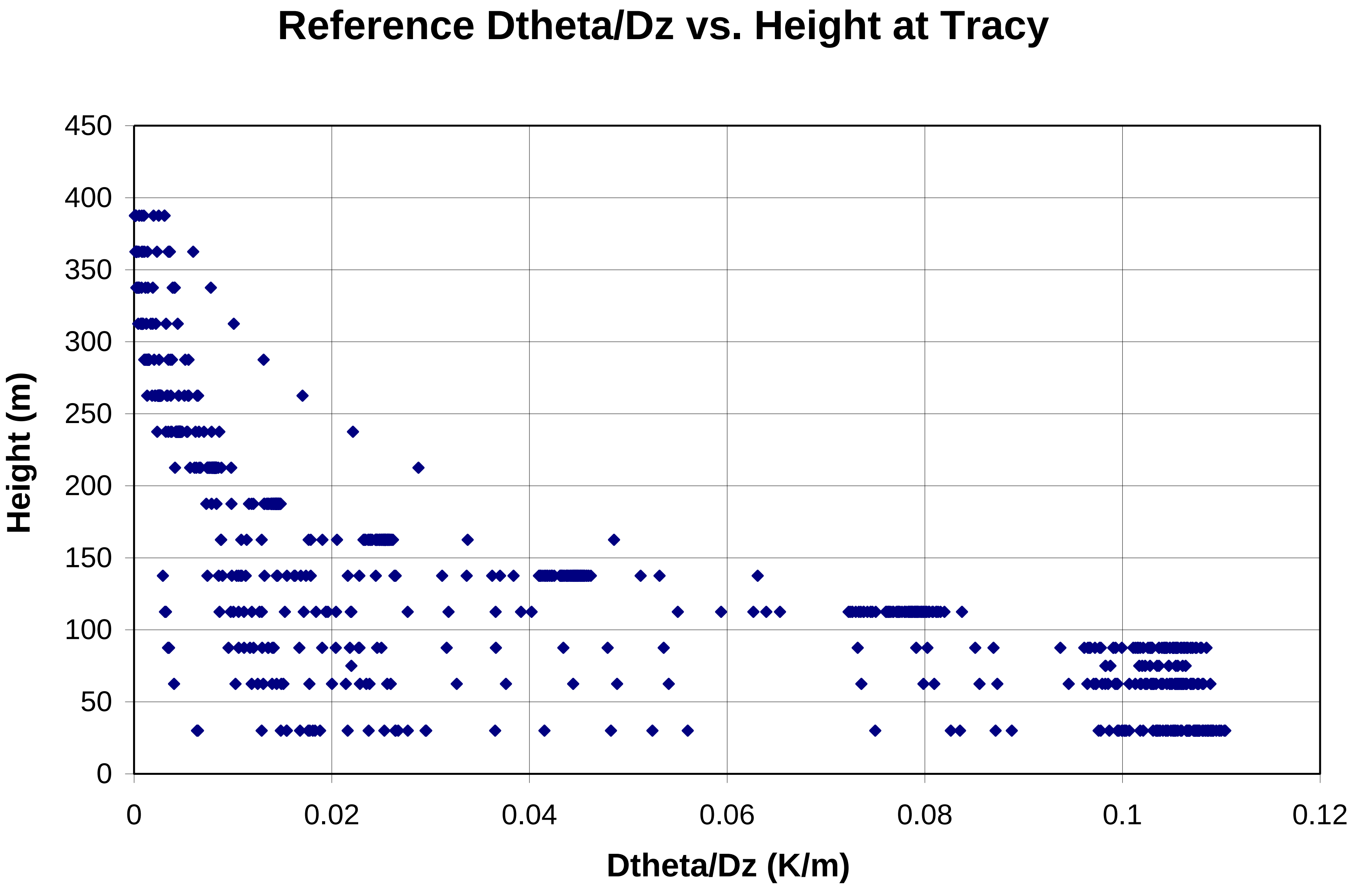
Observed vs. Modified Polynomial Ref. Dtheta/Dz at Tracy



Observed Lapse Rates vs. Height

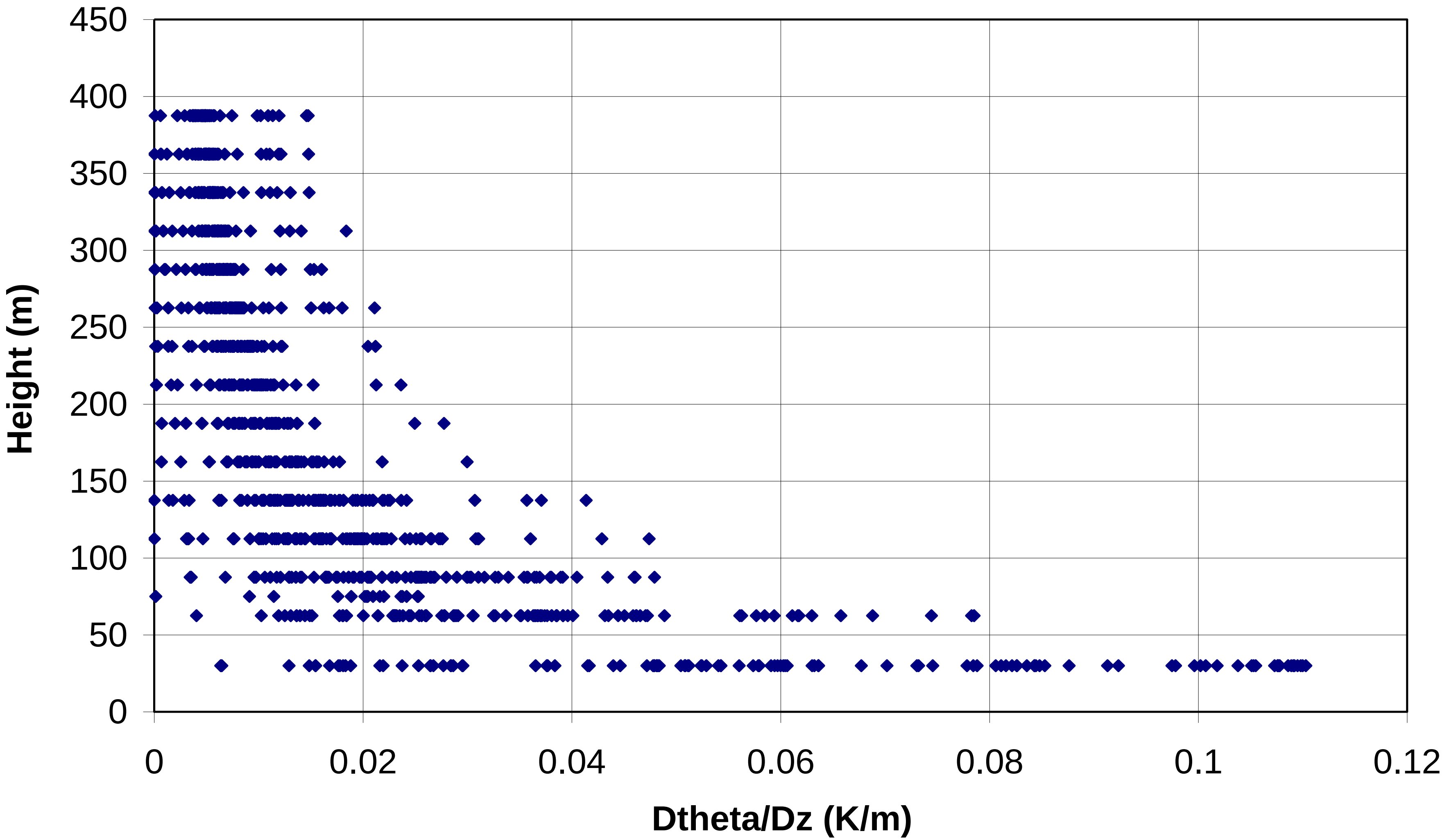


Default Lapse Rate vs. Height

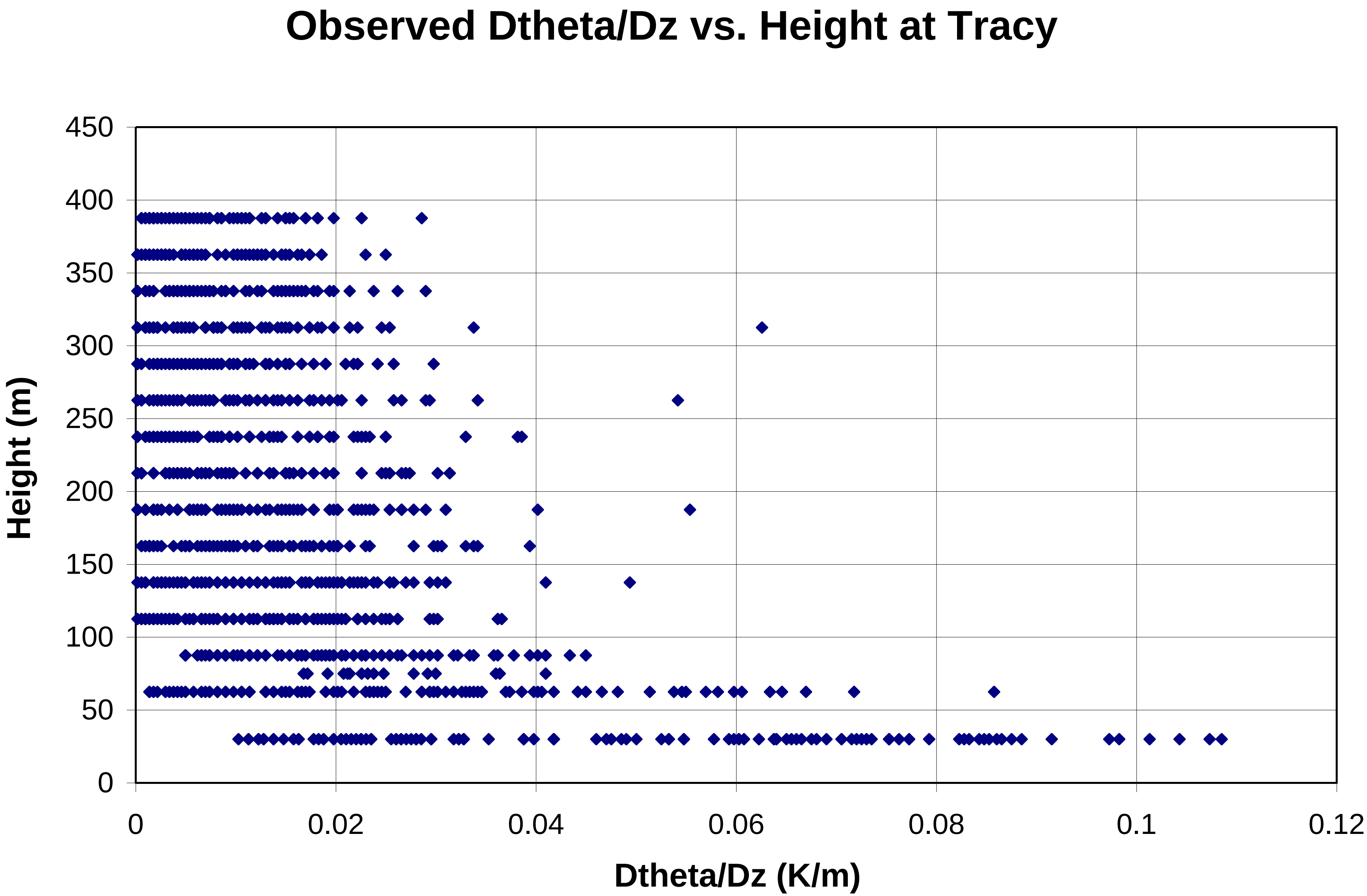


Modified Lapse Rate vs. Height

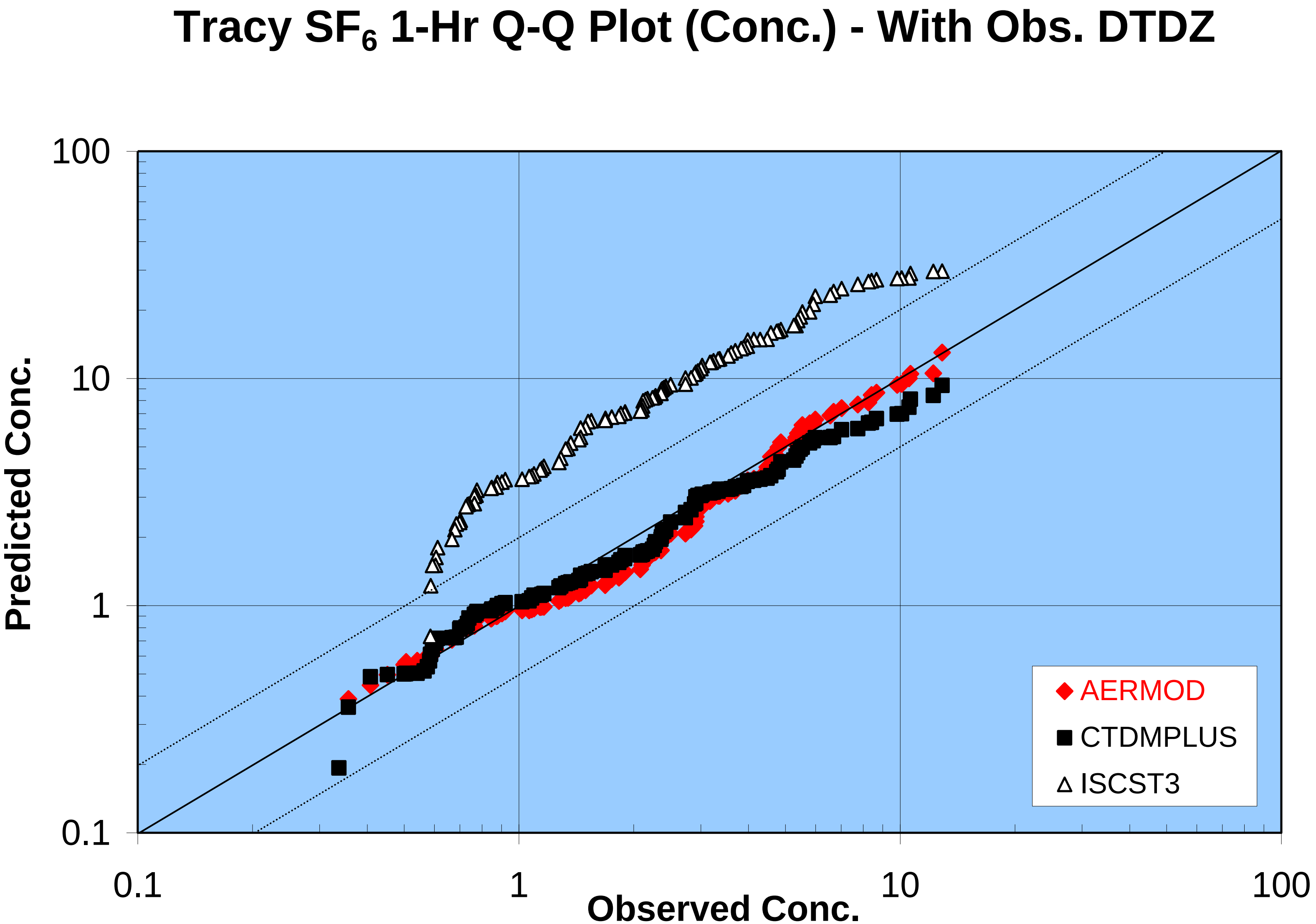
Observed vs. Mod. Poly. Reference Dtheta/Dz at Tracy (A=5, B=5)



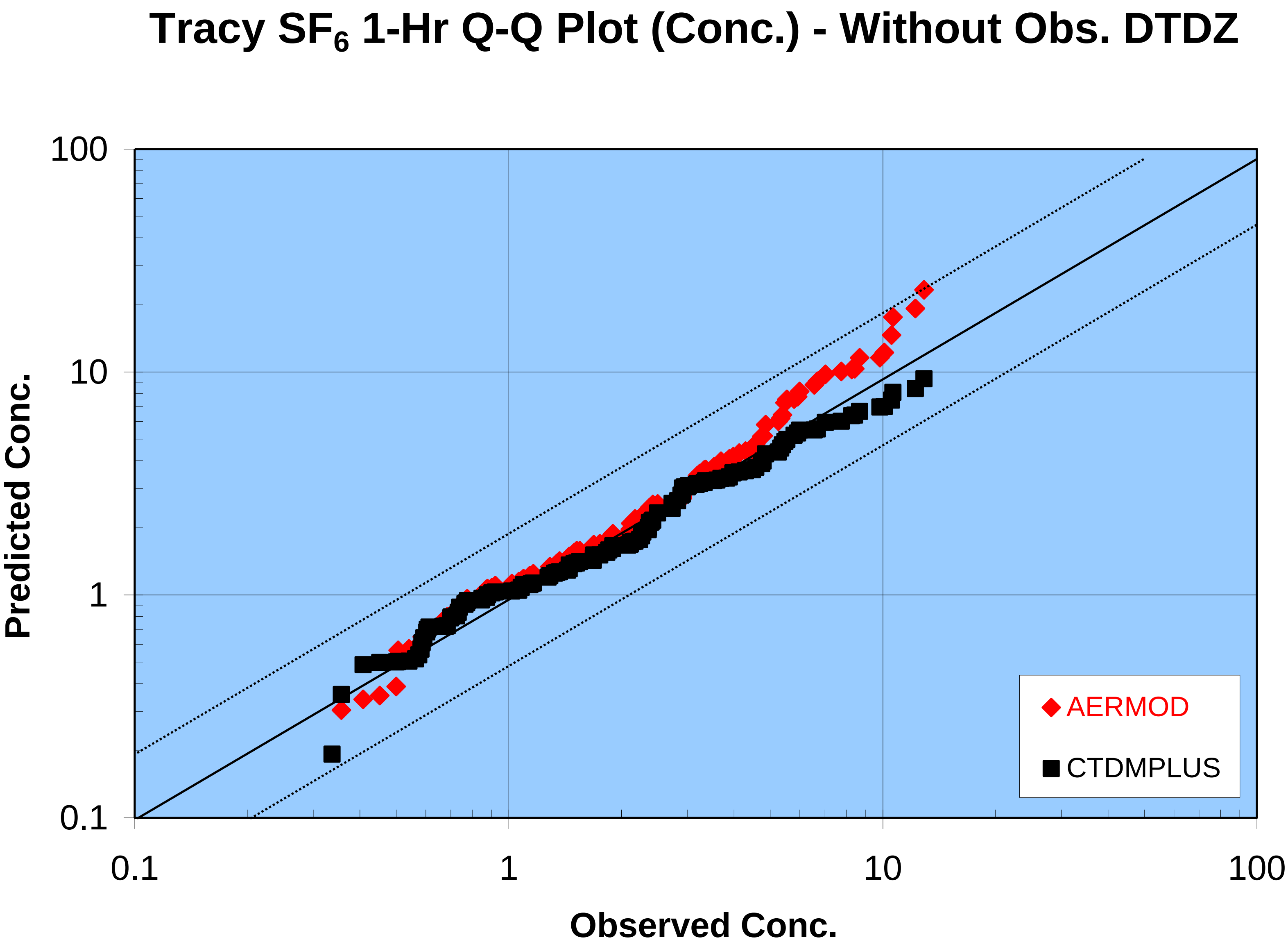
Observed Lapse Rates vs. Height



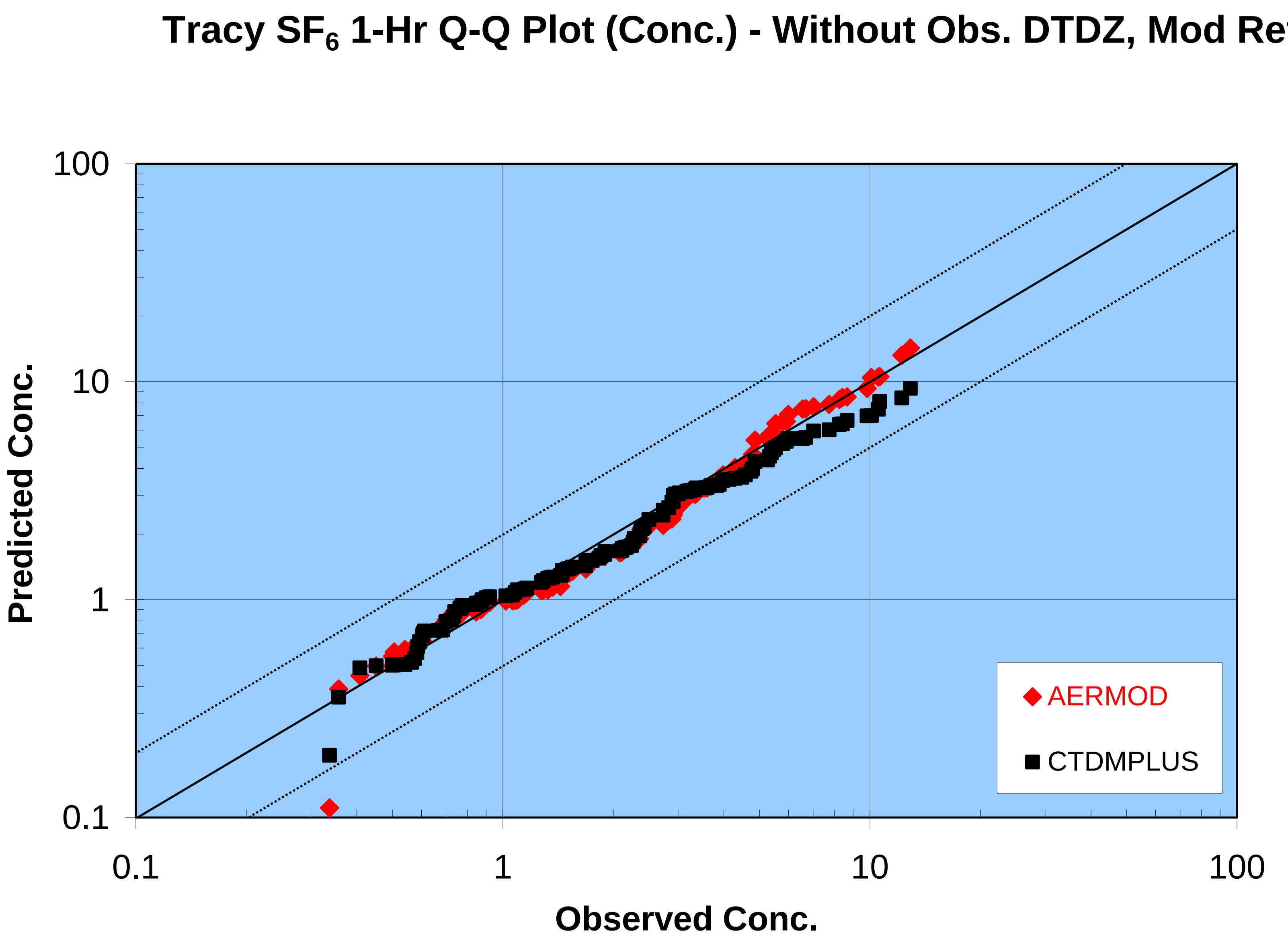
AERMOD Performance with Observed Lapse Rate



AERMOD Performance w/o Observed Lapse Rate



AERMOD Performance w/ Modified Lapse Rate



Urban/Tall Stack Issue: Section 5.1 of AIG

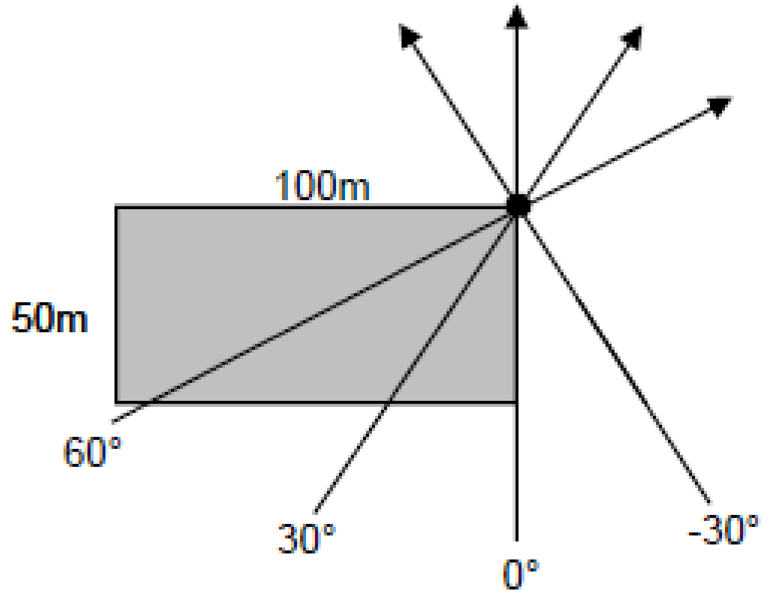
Another aspect of the urban/rural determination that may require special consideration on a case-by-case basis relates to tall stacks located within or adjacent to small to moderate size urban areas. In such cases, the stack height, or effective plume height for very buoyant plumes, may extend above the urban boundary layer height. Application of the urban option in AERMOD for these types of sources may artificially limit the plume height. Therefore, use of the urban option may not be appropriate for these sources, since the actual plume is likely to be transported over the urban boundary layer. A proper determination of whether these sources should be modeled separately without the urban option will depend on a comparison of the stack height or effective plume height with the urban boundary layer height. The urban boundary layer height, z_{iuc}, can be calculated from the population input on the URBANOPT keyword, P, based on Equation 104 of the AERMOD formulation document (Cimorelli, et al., 2004):

$$z_{iuc} = z_{iuo} \left(P / P_0 \right)^{1/4}$$

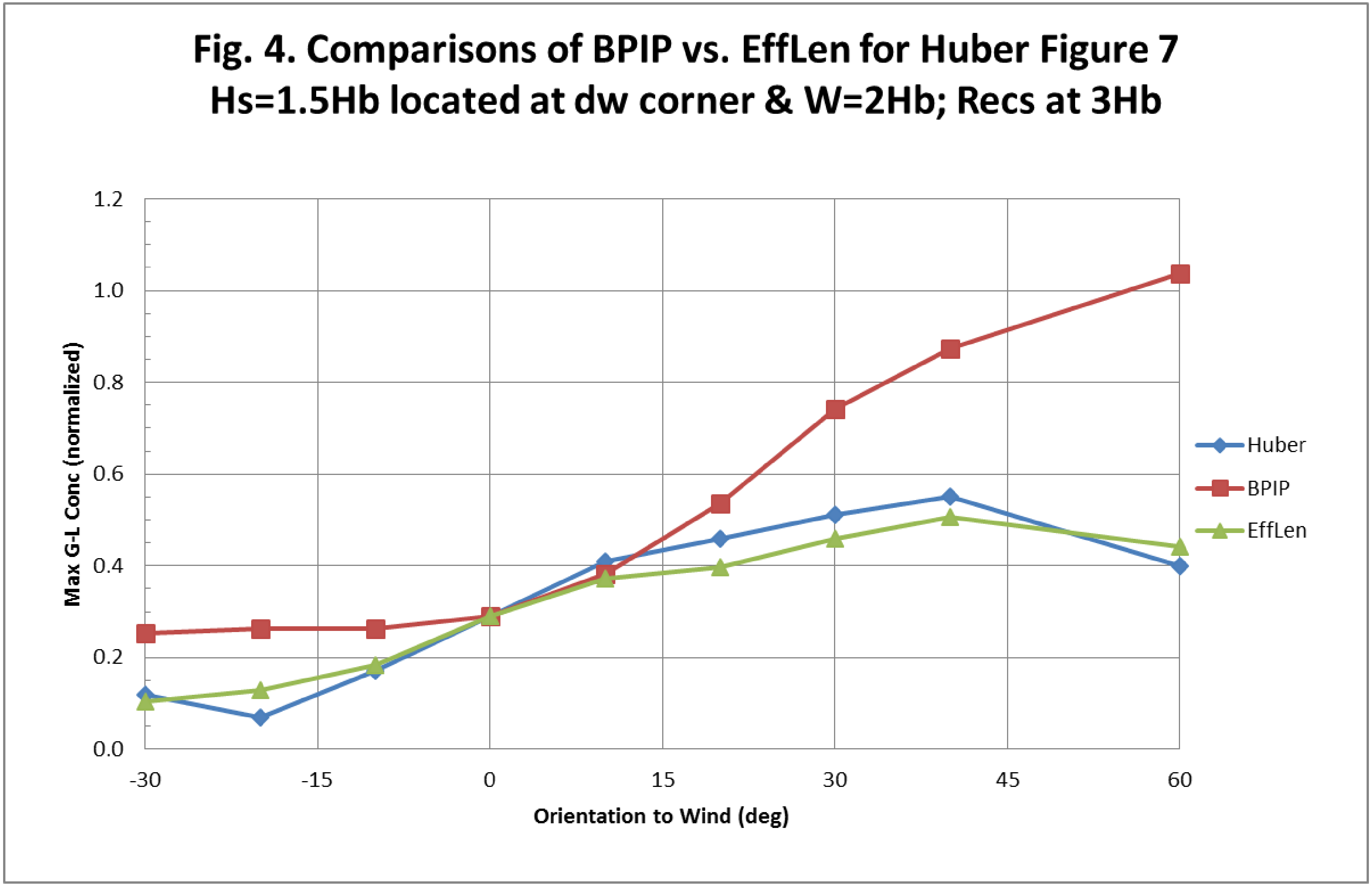
where z_{iu0} is the reference height of 400 meters corresponding to the reference population, P0, of 2,000,000. Exclusion of these elevated sources from application of the urban option must be justified on a case-by-case basis in consultation with the appropriate reviewing authority.

Downwash Issue for Elongated Buildings

Fig. 1. Huber Wind Tunnel Study - Case S2 - Source at Downwind Corner of Building (W=2Hb)



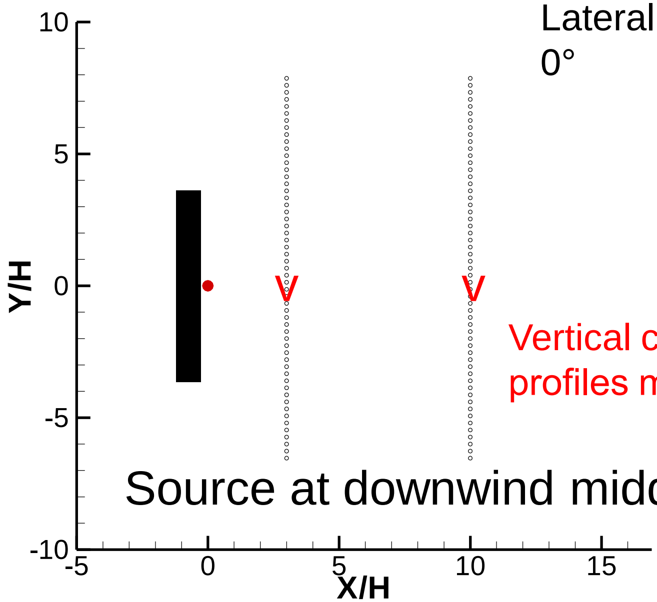
Downwash Issue for Elongated Buildings



Completed & planned measurements
h_s=1.5H

1 x 8 Building

Lateral profiles
0°



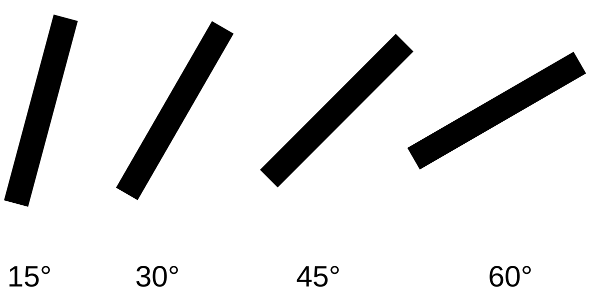
Vertical concentration profiles marked with a ‘v’

Source at downwind middle of building

File names:

BD_1.5H_DM_1x8_0_x=450_z=7

BD_1.5H_DM_1x8_0_x=1500_z=7



File names:

BD_1.5H_DM_1x8_15_x=450_z=7

BD_1.5H_DM_1x8_15_x=1500_z=7

BD_1.5H_DM_1x8_30_x=450_z=7

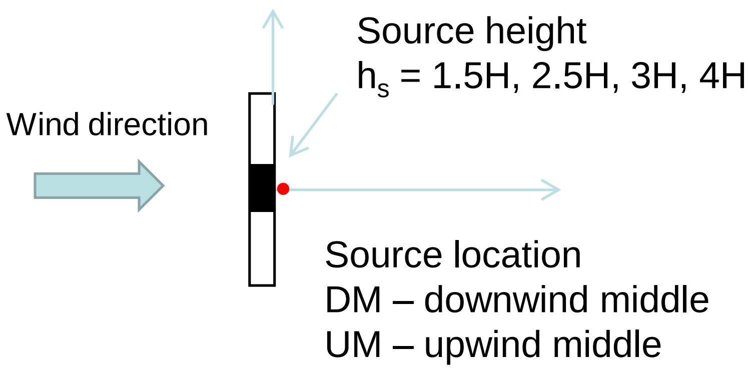
BD_1.5H_DM_1x8_30_x=1500_z=7

BD_1.5H_DM_1x8_45_x=450_z=7

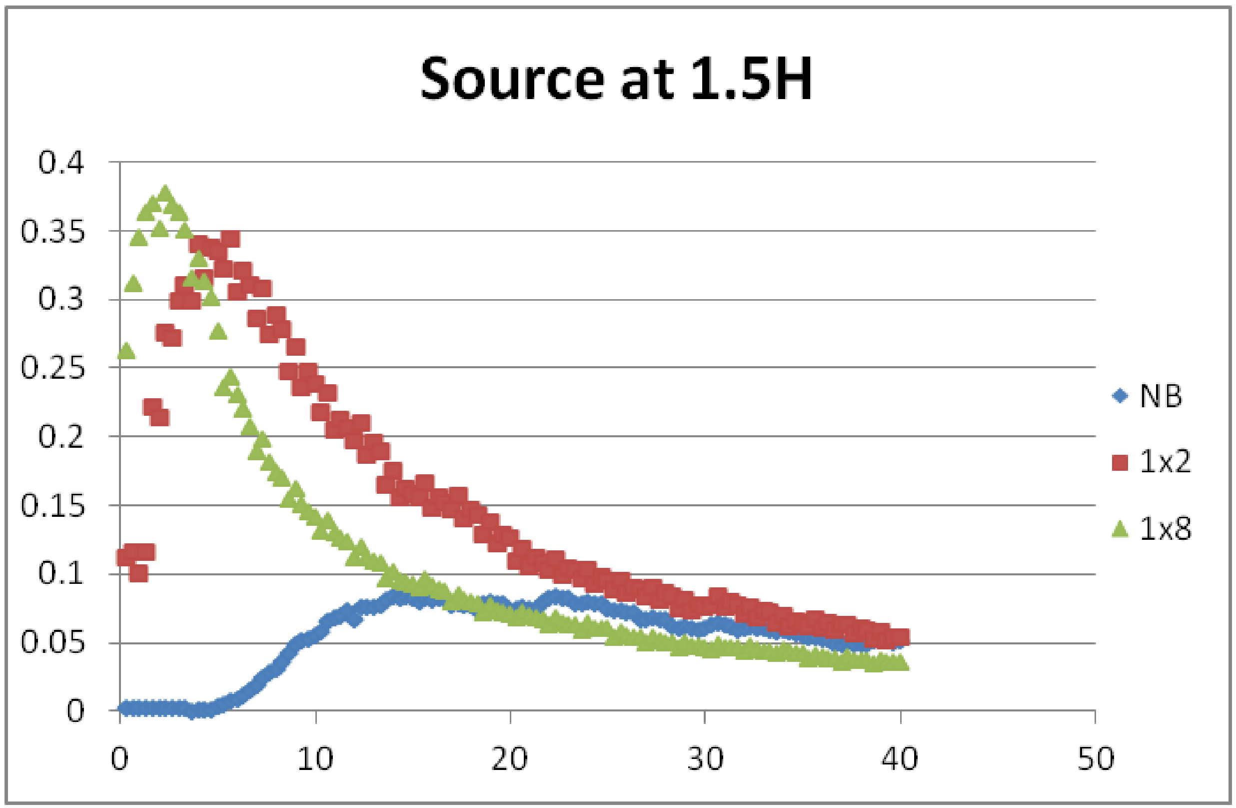
BD_1.5H_DM_1x8_45_x=1500_z=7

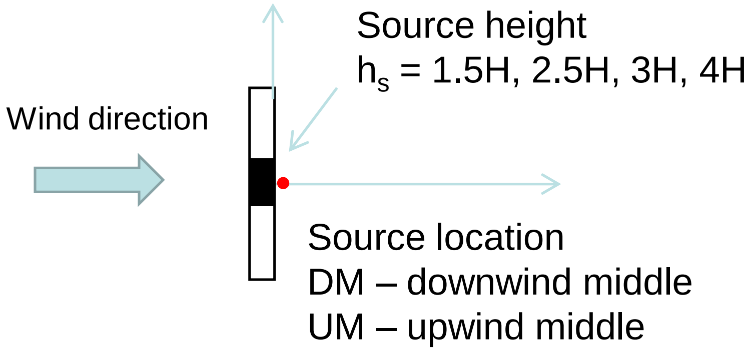
BD_1.5H_DM_1x8_60_x=450_z=7

BD_1.5H_DM_1x8_60_x=1500_z=7

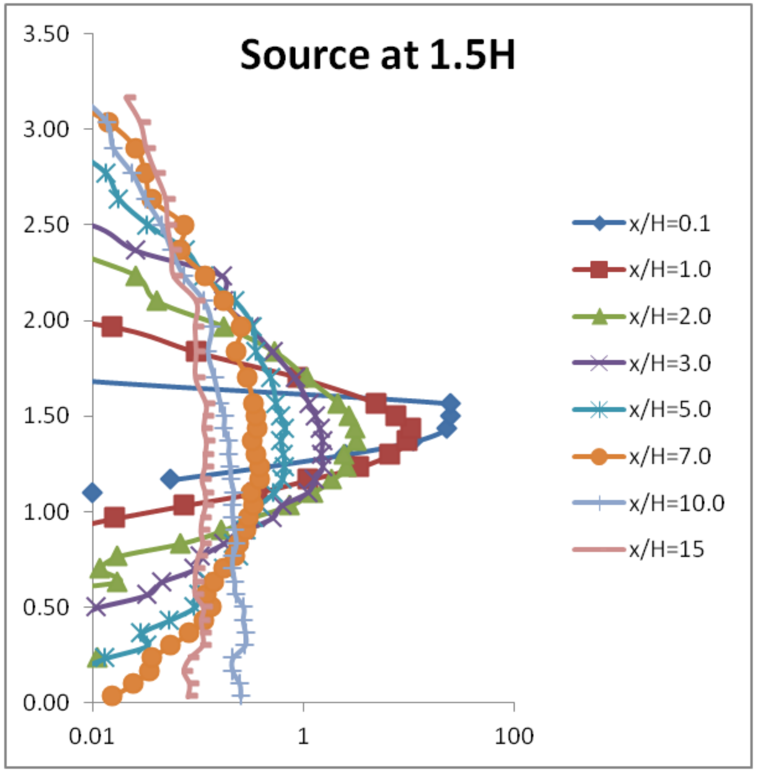


Example results (h_s=1.5H, DM):

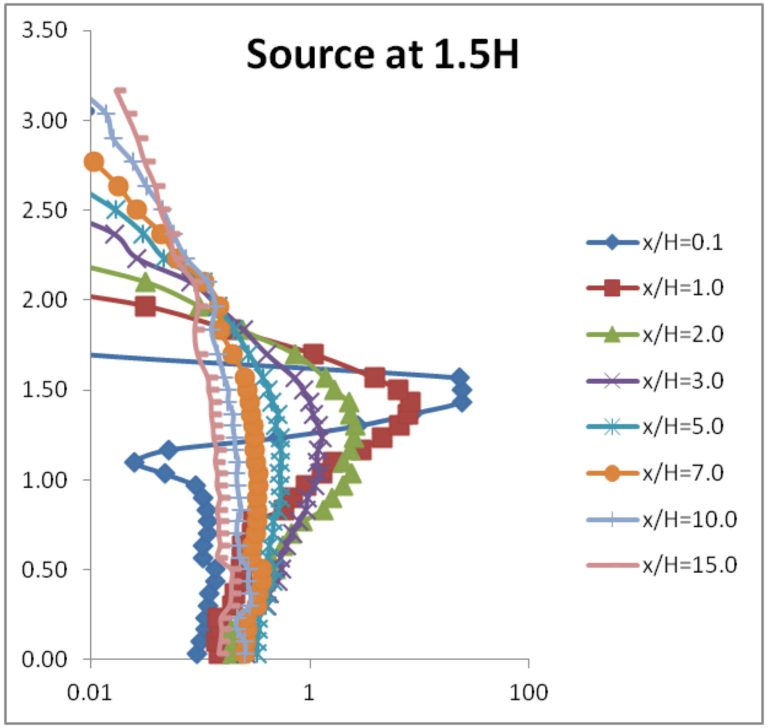




No building

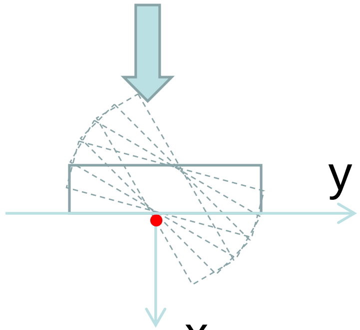


1 x 2 building

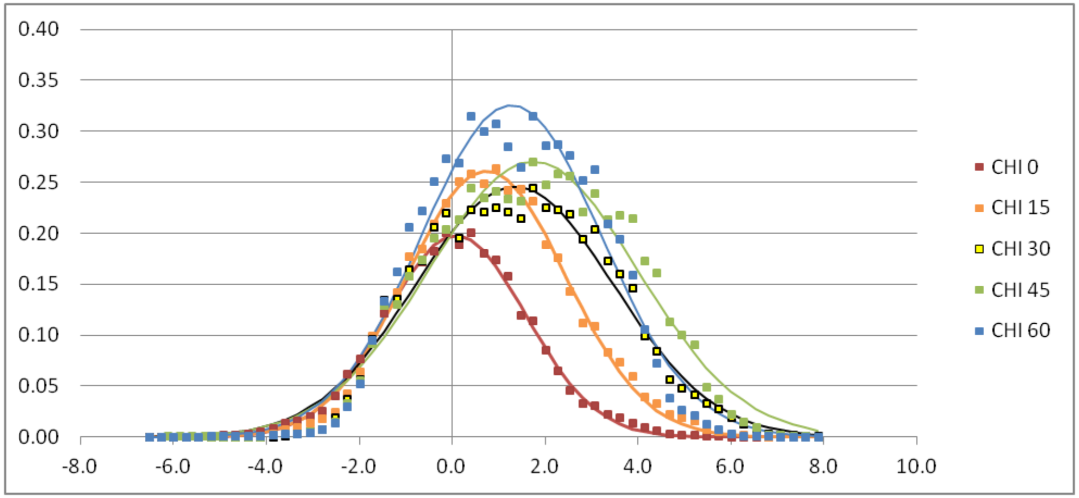


Effect of building rotation on plume width, location and concentration max

Example for:
1 x 4 building,
source @
downwind middle
of building

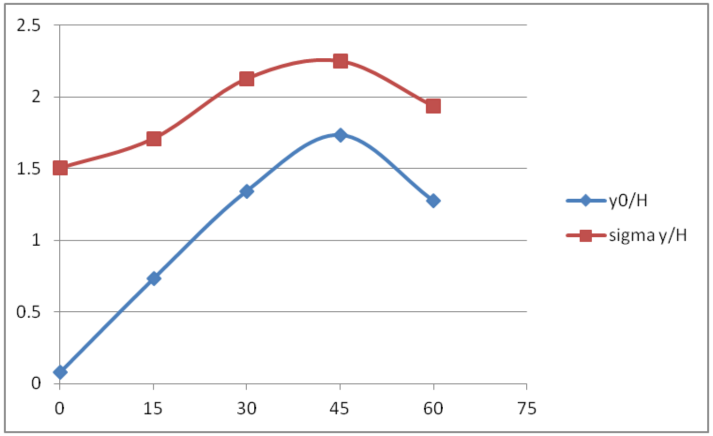


Lateral profiles at x=10H with Gaussian fits



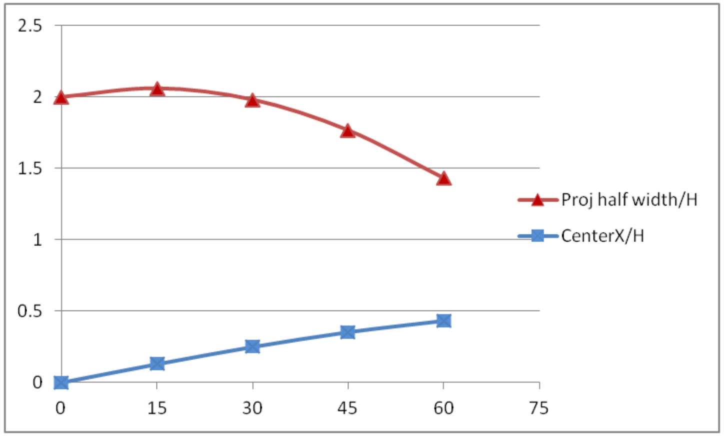
y/H

Location of max & width of plume

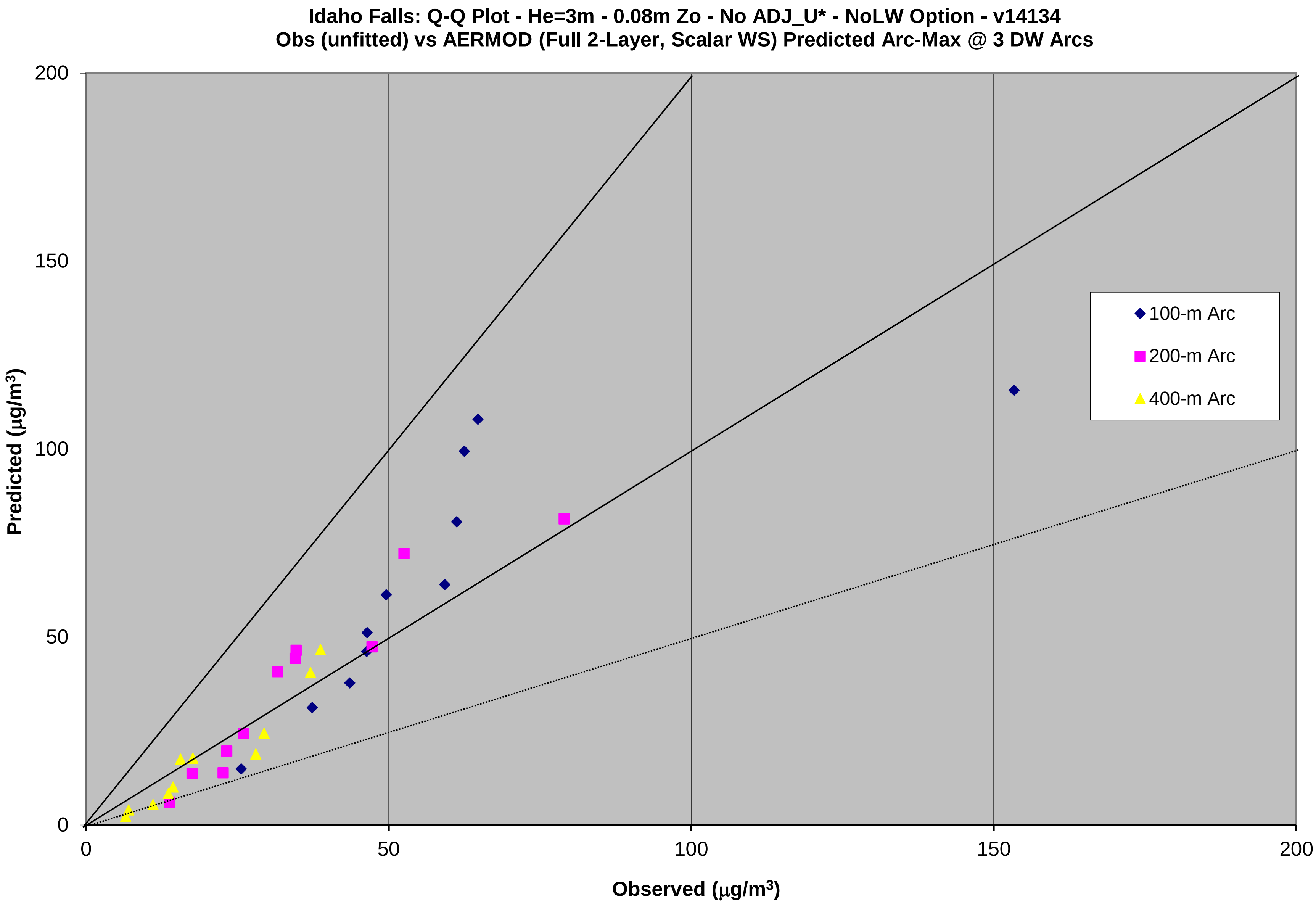


wind direction

Building geometry: center & projected width

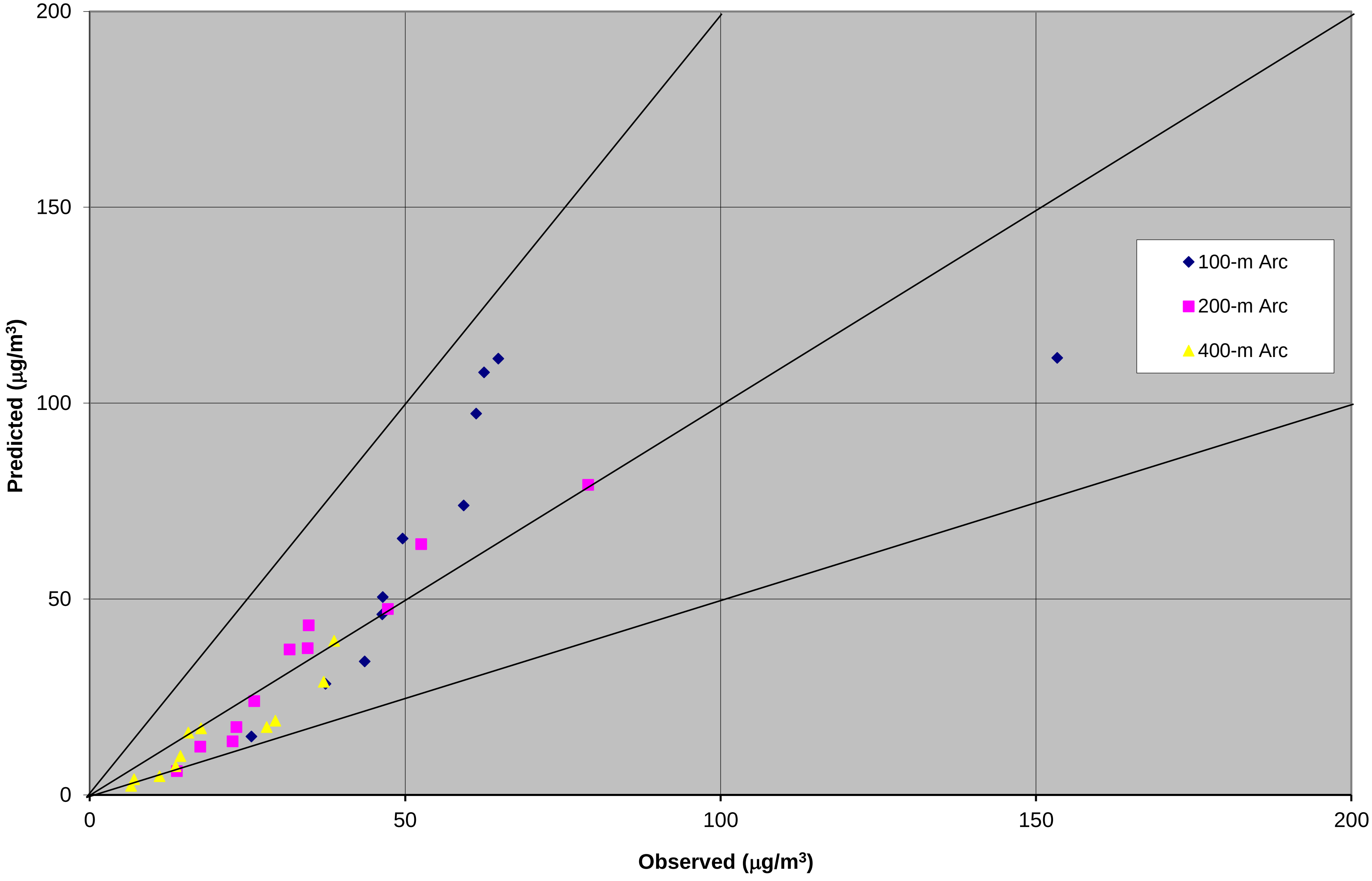


wind direction

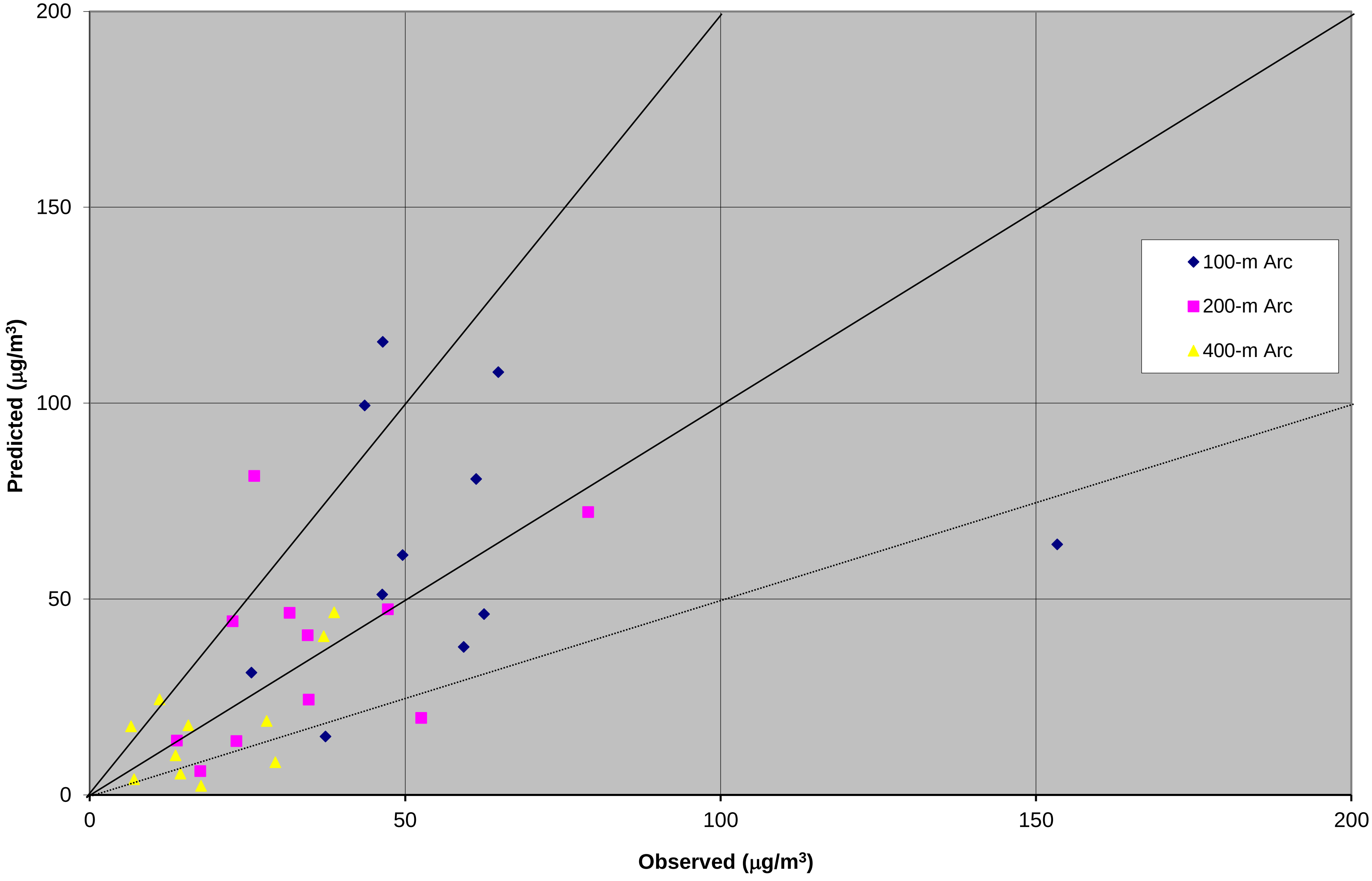


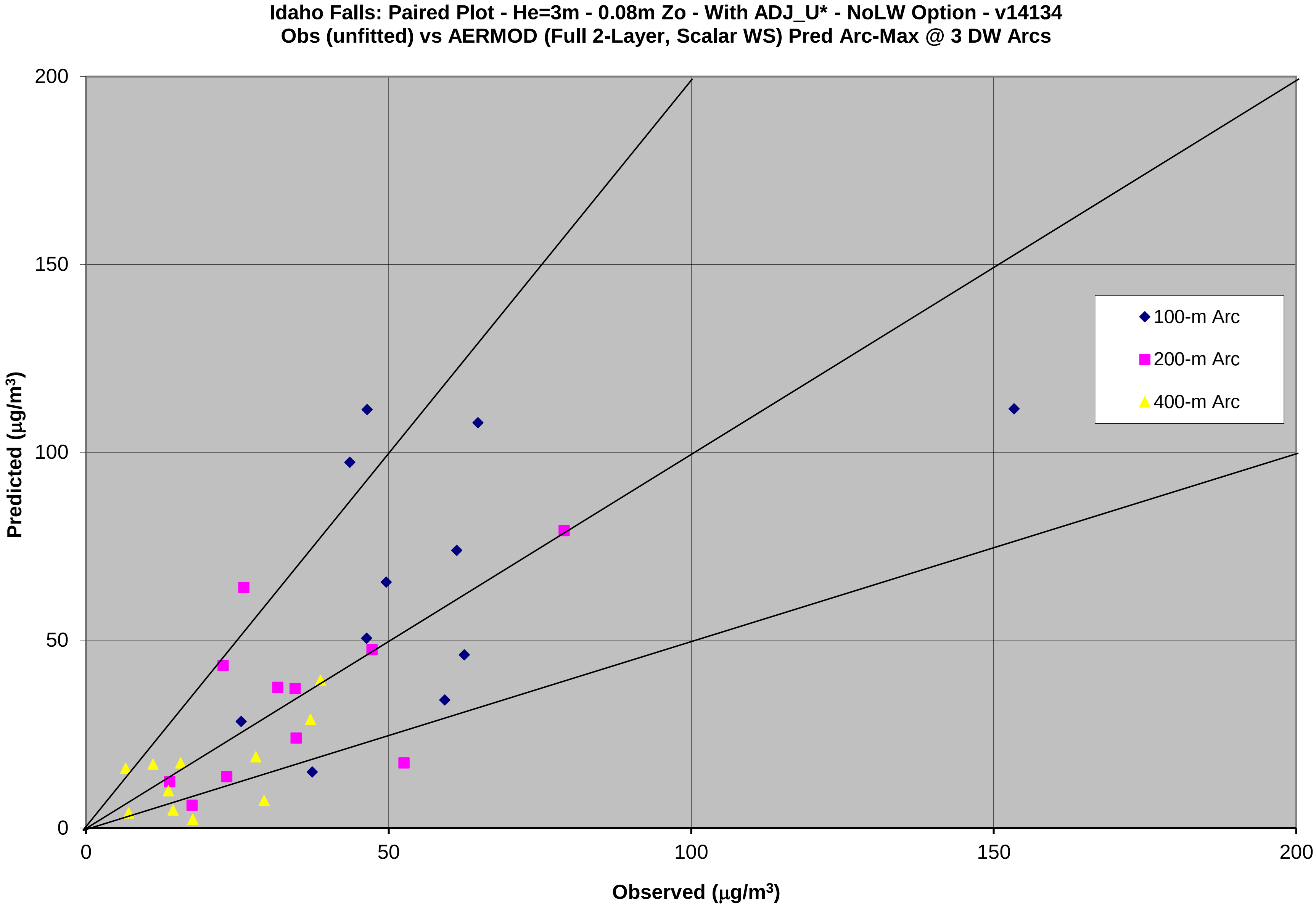
Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - No ADJ_U* - NoLW Option - v14134
Obs (unfitted) vs AERMOD (Full 2-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m3)
Observed (µg/m3)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v14134
Obs (unfitted) vs AERMOD (Full 2-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs

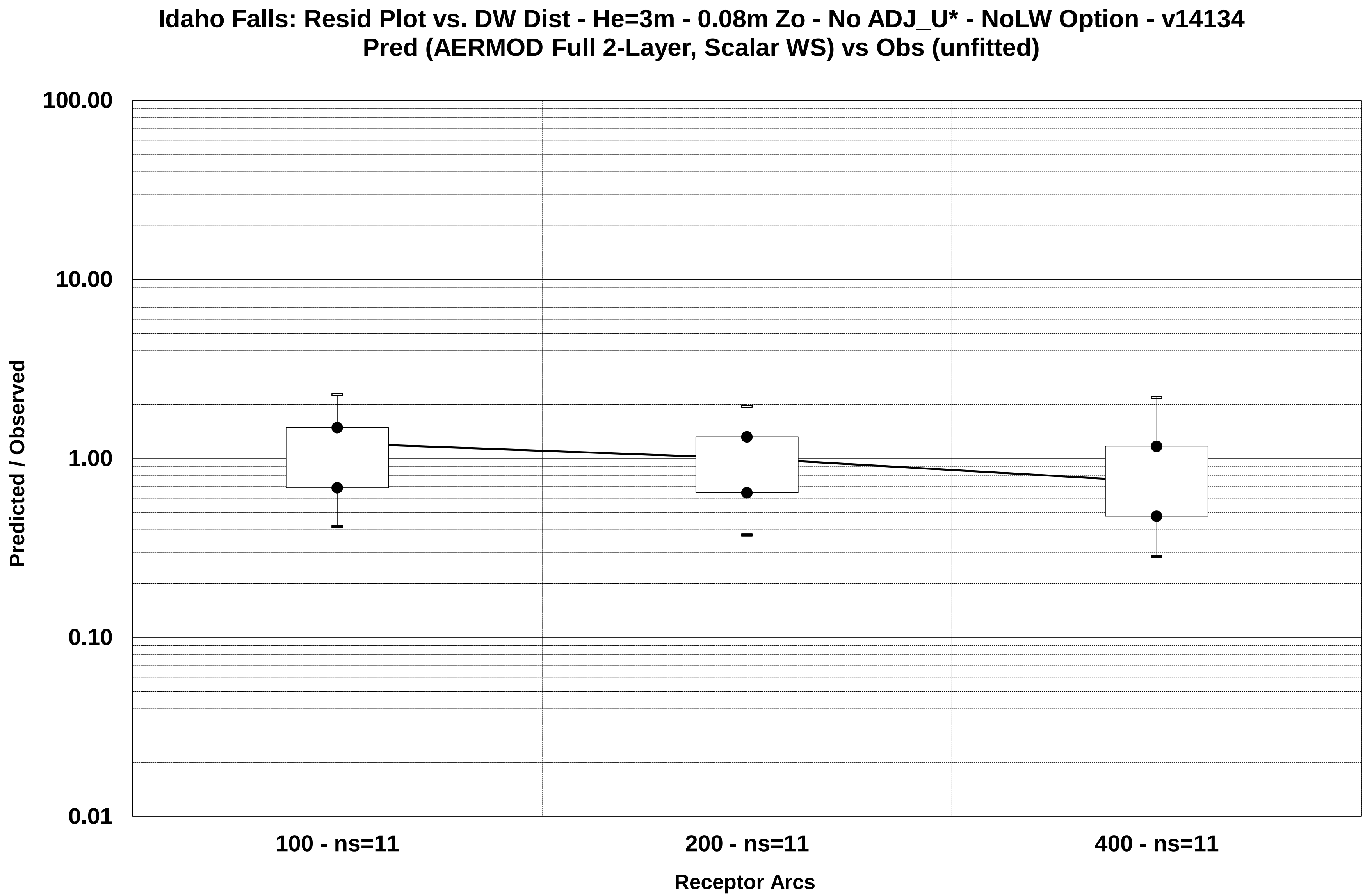


Idaho Falls: Paired Plot - He=3m - 0.08m Zo - No ADJ_U* - NoLW Option - v14134
Obs (unfitted) vs AERMOD (Full 2-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs

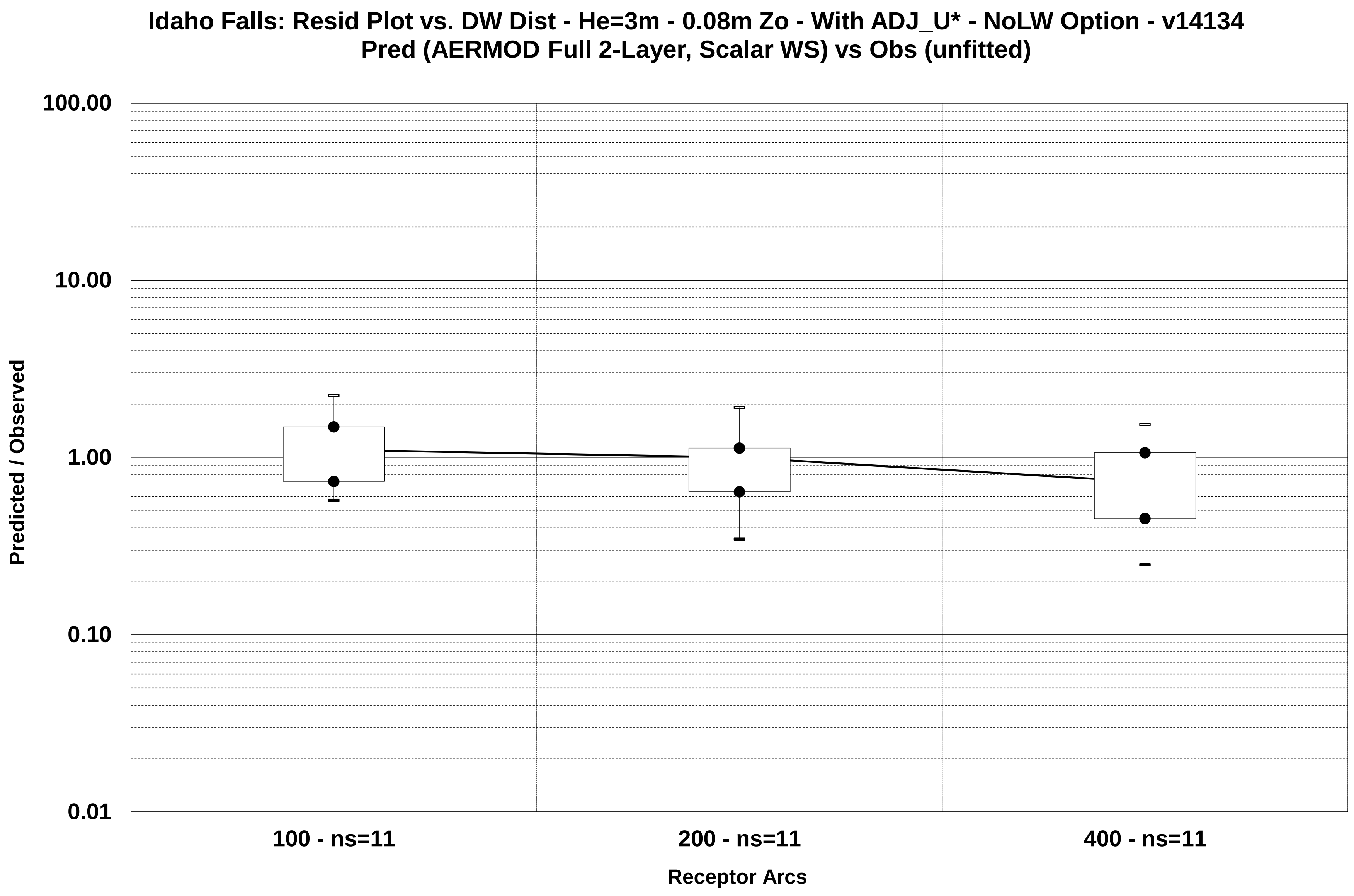




Idaho Falls: Paired Plot - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v14134
Obs (unfitted) vs AERMOD (Full 2-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (μg/m³)
Observed (μg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc



Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - No ADJ_U* - NoLW Option - v14134
Pred (AERMOD Full 2-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs



Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v14134
Pred (AERMOD Full 2-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs